ARE WORMS AFFECTED BY HOST ECOLOGY? A PERSPECTIVE FROM MUDUMALAI WILDLIFE SANCTUARY, SOUTHERN INDIA[1]

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Interspecific comparisons of helminth loads, using helminth eggs per gram of faeces as an index, were done in the Mudumalai Wildlife Sanctuary between May and August, 1999. The host species sampled were chital (*Axis axis*), sambar (*Cervus unicolor*), gaur (*Bos gaurus*), elephant (*Elephas maximus*) and domestic cattle. Helminth distributions in all the species were highly over dispersed and except in the case of gaur the negative binomial distribution gave good fits to the observed data. In general, it was found that the elephant and gaur had higher loads than the cervids, probably due to their larger body size. Among the cervids, sambar had lower loads than chital probably because they are mixed feeders as opposed to chital, which are mainly grazers. Cattle had the highest loads and prevalence of parasites among all the species studied, probably due to the effects of domestication and poor hygiene. Helminth community structure and species diversity was related to the taxonomic distinctiveness of the host. It is thus likely that many interspecific differences in helminth loads can be explained by the existing hypotheses related to host ecology.

Key words: Helminths, *Axis axis*, *Cervus unicolor*, *Bos gaurus*, *Elephas maximus*, cattle

INTRODUCTION

Wildlife conservation, with population health as an important component, has emerged as one of the greatest challenges of our time. However, the existing knowledge on wildlife disease is of little help when dealing with population health, as most of this information has accumulated through "investigation of individual animals rather than populations" (Spalding and Forrester 1993). In spite of this, there have been only a few studies (Arora *et al.* 1985, Watve 1992, Bhatt 1994), in India, on helminths in free-ranging wildlife populations. This according to Davis and Anderson (1971) could be because "it was a common theme that the parasites of wild animals were so perfectly adapted to their host that under natural conditions they would not cause disease." However, research has shown that this premise is not true with parasite affecting the survival of their host directly (Choudhary *et al.* 1987, Nudds 1990) or indirectly (Freeland 1981, Schall 1983, Rau 1984, Saumier *et al.* 1986). For a clearer picture of helminth epidemiology in wild herbivores, it is essential to understand the ecological factors that affect the magnitude of infection in the host species.

STUDY AREA

The study area comprises the Mudumalai Wildlife Sanctuary and National Park, and the Sigur Reserve Forest, situated between 11° 32'-11° 93' N and 76° 22'-76° 43' E. Elevations vary between 900-1,000 m above msl. There is a decrease in rainfall from the western side (1,800 mm/year) to the eastern side (600 mm/year). A high diversity of vegetation types has been observed (Sukumar *et al.* 1992).

MATERIAL AND METHODS

Hosts sampled: Species of host included were chital (*Axis axis*), sambar (*Cervus unicolor*), gaur (*Bos gaurus*), elephant (*Elephas maximus*) and forest grazing domestic cattle.

Coprological study: Helminth eggs per gram of faeces (epg) have been used as an index of helminth load. A representative sample of approximately 2 gm was collected from clearly demarcated, fresh dung piles voided by the target species. Samples were collected in labelled, pre-weighed containers with 10 ml of 10% formalin between 0700 and 0900 hrs daily. The exact weight of faeces collected was calculated by subtracting the weight of the container with formalin from the weight of the container containing the dung sample in formalin. The intensity of helminth infection was determined by the quantitative Sedimentation-floatation Technique developed and standardized by Watve (1992). Prevalence of strongyle genera were calculated using data obtained from larval cultures. Samples for larval cultures were collected separately in cloth bags, kept moist, and cultured in the laboratory within 12-15 hours after collection. Larval cultures for third stage (infective) strongyle larvae were done as per Roberts and O'Sullivan (1949). Larvae were identified with the help of keys provided by Davies (1984). Larvae

Table 1: Distribution of helminth eggs in selected species of wild herbivores and domestic cattle at the Mudumalai Wildlife Sanctuary, Tamil Nadu

Host Species	Sample size	% Infected	Median Load (epg)	Mean Load (epg)	Variance	Index of Dispersion	d-statistic	Negative Binomial Parameters	
								k	χ^2
Chital	214	74.77	2	3.88	191.53	49.32	124.34*	0.76	19.81^{ns}
Gaur	54	85.19	3	11.93	684.82	57.42	67.77*	0.64	40.47*
Elephant	34	85.29	3.5	4.15	45.04	10.86	18.71*	1.38	7.24^{ns}
Sambar	36	58.34	1	1.22	11.49	9.40	17.35*	1.38	3.51^{ns}
Cattle	56	91.07	5.5	7.84	156.35	19.95	36.4*	1.19	12.52^{ns}

epg-eggs per gram of faeces; *- Statistically significant, ns- not significant (see text for details)

cultured from elephant dung were identified by measurements given by Raman (Unpubl. Data).

Terminology: Helminth loads have been expressed in terms of eggs per gram of faeces (epg). In this study, the term has been broadened to include larvae of lungworms also. The term "species" has been used loosely to describe distinct groups of parasites. Thus, for example all fluke eggs are classified as a single 'species'. Though the term 'Operational Taxonomic Unit' as used by Watve (1992) is more accurate, the term species is retained because of familiarity in usage. The total number of such "species" has been used as an index of "Parasite diversity" in the host community. Because of the methodology used, definitions of some terms used here are different from Margolis *et al.* (1982). The term 'prevalence' indicates percentage of samples found to be positive for helminth eggs and/or larvae. The term sympatric is defined as (of biological speciation or species) taking place or existing in the same or overlapping geographic areas (Hanks 1979). This term has been used synonymously with co-grazing.

Statistical Analyses: Calculation of index of dispersion, d-statistic and fitting of the negative binomial distribution has been done as per Ludwig and Reynolds (1988). The d-statistic was termed significant if >1.96. All other statistics were tested at a probability level of 5%.

RESULTS

The distribution of helminths in all host species sampled was highly non-random or over-dispersed as the d-statistic was >1.96 (Table 1). The negative binomial distribution in general gave good fits to the observed data in the case of all the species studied, with the exception of gaur (Table 1). Interspecific comparisons of helminth loads were carried out using three main parameters. These parameters were the prevalence of infection (Percentage of animals infected), median egg load (in epg) and total number of parasite species (parasite species richness) in the study animals. The median egg load was chosen in preference to the mean because in over-dispersed populations a few outlying individuals can drastically affect the latter. The parasites identified in the hosts showed that most host species, with the exception of elephants, had similar parasitic genera (Table 2).

Table 2: Helminth species identified in the hosts sampled

Host	Parasite species identified	Parasitic diversity
Chital	*Trichostrongylus* sp., *Oesophagostomum* sp., *Haemonchus* sp., *Mecistocirrus* sp., *Cooperia* sp., hookworm, *Muellerius* sp., *Dicrocoelium* sp., *Cotylophoron* sp., *Nematodirus* sp., trichurid, fluke, ascarid, strongyloid, anoplocephalid and spirurid	16 species
Sambar*	strongyle, fluke, *Muellerius* sp. and strongyloid	4 species
Gaur	*Trichostrongylus* sp., *Oesophagostomum* sp., *Haemonchus* sp., *Mecistocirrus* sp., hookworm, *Muellerius* sp., fluke, protostrongylus, strongyloid, anoplocephalid, trichurid and spirurid	12 species
Elephant	*Murshidia* sp., *Quilonia* sp., *Decrusia* sp., *Bathmostomum* sp., fluke, spirurid and anoplocephalid	7 species
Cattle	*Trichostrongylus* sp., *Oesophagostomum* sp., *Haemonchus* sp., *Mecistocirrus* sp., *Cooperia* sp., hookworm, fluke, ascarid, strongyloid, *Moniezia* sp., trichurid, *Dicrocoelium* sp. and *Nematodirus* sp.	13 species

* Larval culture data not obtained for host species.

DISCUSSION

In this study, egg per gram of faeces (epg) was used as an index of helminth load in the host. Though this method has limitations as pointed out by Foreyt and Trainer (1980), faecal examination is non-invasive and thus has great appeal especially in wild animals. Because of positive correlation between worm size and egg output (Skorping *et al.* 1991), egg outputs can be considered to be an accurate indicator of parasite biomass, if not numbers. Faecal egg counts can thus give very valuable assistance in studies concerning helminth populations (Roberts *et al.* 1951).

Prevalence of infection and median egg loads: It was found that the two larger herbivores sampled, namely elephants and gaur, had the highest prevalence of infection (85.29% and 85.19% respectively) and median loads (3.5 and 3 epg respectively), as compared to that of cervids — chital and sambar. This could be due to three major reasons. Firstly, larger animals tend to consume large quantities of food and water, and thus have greater chances of picking up infective parasitic stages (Kennedy *et al.* 1986). Secondly, as larger animals have larger gastrointestinal tracts, the "crowding effect" as described by Read (1951) is less likely to be of importance, thus allowing these animals to support larger numbers of parasites without reductions in parasite size and fecundity. Thirdly, as body size increases there is a decrease in predatory pressures. In Mudumalai, sambar and chital are preyed upon by leopards, tigers and wild dogs, while gaur is mostly preyed upon by tiger. Elephants do not form the usual prey base of any carnivore. Since parasites can decrease the ability of animals to escape predation either directly, by reducing running stamina (Schall *et al.* 1982) or indirectly, by causing debility (Soulsby 1982), animals like deer with high predatory pressures are likely to evolve higher resistance to infection by way of natural selection. Additionally, if carnivores select prey with poor body condition (Kruuk 1972) they may selectively remove animals with high parasite loads from the population, thus reducing a major source of infection to other animals.

Among the cervids studied, sambar had lower prevalence of infection and median egg loads (58.34% and 1 epg respectively) as compared to chital (74.77% and 2 epg). It has been observed that sambar is a mixed feeder, both grazing and browsing, as compared to chital which is predominantly a grazer (Schaller 1967). Since browsers tend to have lower loads of parasites (Horak 1984), mainly as a result of less contact with the infective stages of the helminths, which are found mainly in the soil or on grass, the higher helminth load in chital can be attributed to this reason.

Cattle were found to have the highest levels of parasite prevalence (91.07) as well as median egg loads (5.5 epg) and this could be due to two reasons. Firstly, it has been hypothesised that domestication tends to tilt the "natural balance" in favour of parasites (Gordon 1948). Secondly, the cattle grazing in Mudumalai are kept in pens during the night. The high levels of crowding in these pens will create an environment that is conducive for the increased transmission rates of parasites (Solomon 1965). Poor hygiene in the pens is likely to exacerbate these high transmission rates, and thus contribute both to the high parasite prevalence rates and helminth loads observed in cattle.

Parasite species richness: The richness of parasite fauna varied widely among different species of host. Taxonomically related host species tend to share parasite species (Cameron 1964, Segun 1971), which may be due to immunological reasons (Freeland 1983). Thus, host species with a large number of related species in the same area can be expected to have high parasite species richness. This was so in our findings, with chital having the greatest parasite diversity (16 parasite species) followed by gaur (12 species) and forest grazing cattle (13 species). Elephants with no close relatives had the lowest species diversity (7 species). Sambar was not considered for comparison, as larval culture data for this species could not be obtained. Using larval culture data, which allows identification of strongyles up to the generic level, it was found that the ruminants (chital, gaur, cattle) had very similar parasitic genera. This is well in agreement with Horak (1981). Elephants, which were phylogenetically distinct from other herbivores, were found to have a distinctive strongyle community structure composed of *Murshidia* sp., *Decrusia* sp., *Quilonia* sp. and *Bathmostomum* sp. Generic level identification of other parasites was only possible in a few cases wherein the egg morphology was very distinct (e.g. *Trichuris* sp.).

From the management point of view, the fact that the cattle entering the Sanctuary have the highest worm loads among the herbivores, and also have many parasitic genera in common with the wild herbivores, should be viewed with concern. Dharmarajan *et al.* (2003a, b) shows that such cattle may have adverse effects on chital populations.

In conclusion, it may be stated that differences in parasite loads and helminth community structure between different species of wildlife and forest grazing domestic cattle in Mudumalai can be explained by the existing ecological hypotheses. The major parameters are likely to be species of host, phylogenetic distinctiveness, feeding habits and domestication. More work is required to identify the relative importance of the various factors influencing the distribution of helminths within and between populations of host species studied in Mudumalai.

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